Anonymous Referee #2 Received and published: 19 December 2018

Review of "Sediment transport modelling in riverine environments: on the importance of grain-size distribution, sediment density and boundary conditions" by Lepesqueur et al. This paper deals with improvements brought to the sediment transport module (SISYPHE) of the TELEMAC model by introducing multiple sediment sizes with specific densities, accounting for river bottom and banks contributions. The paper is well structured and easy to read. The introduction provides a relevant state of the art and clearly positions the study with respect to parent studies in the field of fine, short-term

We would like first to thanks the second reviewer for his careful reading of the paper and his pertinent remarks and comments.

The modelling framework section mainly consists in describing the rationale of the coupling between TELEMAC and SISYPHE and ad hoc adaptations, without noticeable changes in the underlying physics of the models. The tested adaptations are put into practice on a single study site in moderate flow conditions, which although relevant seems a bit too limitative to explore all possibilities offered by the new formulations. The Results and discussion section is fair, most of the Figures and interpretations are convincing. I also rather agree with the conclusions and future scopes. In my opinion this paper is worth publication for the improvements it describes to an already-validated and well-known modelling approach, even if this kind of contribution would have deserved a wider database of river contexts and stage conditions. In its present form it is more of a convincing feasibility study than a definitive proof. My second objection is that the 3D features of the model are rather "silenced" throughout the paper, at least not taken advantage of - maybe due to experimental difficulties (it is not easy to "measure" as many flow features as are predicted on these scales) A few minor issues still need to be handled, listed in the following. Title "Boundary conditions" is not explicit enough for me - do the authors mean "upstream boundary conditions" or sediment availability on the bottom and river banks?

We thank reviewer2 for this comment. We will change "boundary condition" by "upstream suspended sediment concentrations".

Abstract P1L11 - I would rather say "the spatial pattern of particle distribution and density" instead of "particle site distribution and density"

We thank reviewer2 for this comment. We will follow his recommendation.

P1L13 - "rising and flood events" is a repetition

We thank reviewer2 for this comment. We will modify the manuscript accordingly

P1L18 - It may seem somewhat tedious to only mention the upstream condition while a downstream control also exists, as Fr«1 most likely almost everywhere. However, this point is mentioned here and there in the paper and I don't know if it should be recalled/announced here.

Here, we tested the sensitivity to the way the upstream suspended sediment concentrations are defined (distributed on up to 10 size classes). Downstream, we compared the results of the different numerical simulations and the SSC measurements. We did not impose the downstream sediment concentrations in the model. However, due to the presence of the dam, the measure water depth is used as a downstream (flow) boundary condition. We will clarify these points in the revised version of the manuscript.

C2 HESSD Interactive comment Printer-friendly version Discussion paper

Introduction

P2L19 - "erosion, transport and deposition" by chronological and phenomenological order (and also P3L13)

We thank reviewer2 for this comment. We will follow this recommendation.

P2L20 - I think the reader deserves a bit more tips on the reason why "those two parameters control the area where..."

We thank reviewer2 for this comment. We changed the sentence as follow:

"The fall velocity controlled by sediment density and size determines the preferential deposit zones"

P2L25 - Could the authors provide additional indications regarding the conditions of the Durafour et al. study?

Durafour et al. (2014) compared bed load during tidal cycles and empirical formulations: they found that distributing bed load fluxes over a larger number of grain size classes significantly reduced differences between measurement and in situ observations. We will mention this in the revised version of our manuscript.

P2L34 - "first" instead of "First" Modelling framework

We thank reviewer2 for this comment. We will follow this recommendation.

P3L14 - "which" instead of "and" before "allows"

We thank reviewer2 for this comment. We will follow this recommendation.

P3L26 - I thought z1 was a "fictitious" horizontal level - its definition here is pretty unusual and the sense of "deeper vertical plane" is not straightforward at least to me.

We thank reviewer2 for this comment. We will change by "altitude of the first horizontal plane above the bottom".

§2.4 - The (high) probability of flocculation for cohesive sediments is disregarded and only mentioned in the future scopes. Could the authors provide insights on the flow regimes in which flocculation can be ignored or will certainly occur, thus outlining the conditions of validity of the present approach?

The flocculation process is well documented in estuary system, lake or deep ocean. In riverine environment (especially in small rivers like the Orne river) only a few authors discussed it and there is consequently a lack of literature with respect to flocculation modelling in this kind of environment. The shear rate which is one of the main physical parameter responsible for collision-aggregation-disaggregation is generally high in this kind of environment which do not allow the formation of macroflocs: the variation of fall velocity of cohesive sediment is hence limited compared to an estuary. The flocculation is not the only process that should be taken into account, indeed in riverine environment terrestrial aggregates, aquatic aggregates (eroded substratum) and flocs (aggregates formed in the water column) are also present and as a consequence the different aggregates do not have the same composition and properties (shear strength, density, fractal dimension).

In complement, I think the 63µm-limit is that between silt and the finest sand particles - this should also be mentioned.

We thank reviewer2 for this comment. we only mentioned in §2.4 the distinction of the properties (cohesion or not) and not the names of the grain size class. We changed our sentence as follow: "In SISYPHE, the distinction between cohesive (i.e., mud) and non-cohesive sediment is based on the sediment diameter: the sediment is considered cohesive below 63 µm (silts and clays) and non-cohesive beyond 63 µm."

P4L25 - Value of M? Is ï ¸At'c0 ïC ´z ï ¸At'cd and what ´ are their typical values?

The erosion constant M has been set to $2.4.10^{-5}$ kg/sm^2. Typical values are ranging from 10^{-5} to 5.10^{-3} kg/sm^2.

(We can not read the second question, we supposed it is referring to the shear stress and the critical shear stress)

The critical shear stress of the mud has been measured with the help of a scissometer: the critical shear strength of mud erosion was estimated at 0.48 Pa for the top layer and 0.84 Pa at 15 cm depth (linear interpolation is performed to attribute to each bottom's layer the appropriate critical shear stress). For consolidated sludge, the typical value of the critical shear stress would be between 0.3 and 6 Pa.

P4L27 - Ws is not mentioned.

We thank reviewer2 for this comment. We will mentioned this corresponds to the fall velocity.

P5L5 - "kinematic" instead of "cinematic"

We thank reviewer2 for this comment. We will follow this recommendation.

P5L17-19 - I think this section should be moved after the cases of cohesive and non-cohesive sediment have been described.

We thank reviewer2 for this comment. We will follow this recommendation

P7L15-21 - Have you tried different upstream initial profiles or do you consider the one you chose is typical of pre-existing equilibrium conditions? If so, are the results only valid for such conditions? Study Area...

The paragraph p7L15-21 concerns the strata of the numerical model: we have decomposed the layers of the bottom in the initial state according to the median diameter and we only tried this one.

P10L8-13 - These elements of discussion are fair and welcome but do you think the hypotheses assumed are strong hypotheses. Do you have any "independent" indications that your starting hypotheses are correct or are they just default hypotheses (or else, do the results drastically change if these assumptions prove wrong?)

The spatial distribution of sediment grain size in the river bed potentially plays an important role in the erosion and deposition fluxes (depending on the flow conditions). However, knowing the actual distribution of sediment grain size is not possible and this leads to local overestimation or underestimation of sediment fluxes. However, only limited variations were observed on the collected bottom sediment samples (four transects). We will add further explanations in the manuscript.

Results and discussion

P12L26 - "The need for long simulations", does this hold for non-equilibrium initial conditions and if so, do you think it means the coupling is not strong or dynamic enough - as in quasi-static approximations for sediment movement, for example?

In this context, the phrase "need for a long-term simulation" refers to the need for a numerical adjustment of the sediment distribution and the bathymetry at the beginning of the simulations in order to avoid unrealistic sediment fluxes..

The quasi-static approximation of the movement of sediments is indeed questionable, particularly in the case of sheet flow, fluid slime formation or small bedforms (eg ripples formation): another approach, such as modelling in two-phase flow, would be of course more appropriate, but also more time consuming. We will add a remark on this in the manuscript

P13L19 - Delete "slightly"

We thank reviewer2 for this comment. We will follow this recommendation.

P15L10 - From the point of view of physical processes at play, one may think that increased water stages and stream power would both dislodge and move heavier bottom particles and allow access to different sediment "sources" on the banks. Is it compatible with your approach or could it be described within it (for a stronger reconnection with experimental observations)?

The dynamic coupling of Telemac and Sysiphe is actually meant to allow simulations for higher/lower flow rates. We believe that the model would not need further development to simulate sediment transport during higher magnitude flood events. Of course, this is an interesting perspective to test the same model in such conditions, but we do not have the necessary validated dataset at that time.

Conclusion

P19L4-5 - It is unclear what boundary condition representation means Future scope

We thank reviewer2 for this comment. This sentence resume what we did in this study, hence the boundary condition there mean the SSC imposed at the upstream boundary condition: we will add the word "upstream SSC" in the sentence to make it clearer.

P20L10-11 - It is not good practice to quote more than 5 references at once - please split the list and comment on the differences between studies and contexts.

We thank reviewer2 for this comment. We will split the list of the quotations.